A GIS Based Assessment of some heavy Metal Concentrations in Milk and Rural Dairy Products in Sohag Governorate, Egypt

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1. Abstract

This study was carried out to assess and map some trace elements in raw buffalo's milk and some house - made dairy products collected from some villages of Sohag. The representative villages named as Nza El-hesh, Enibes, Bnawett, Basona, Abar El-waqf, El-hwaweash, Arab El-sabha, Awlad Salem, El-mgabra and Mzata. cadmium and lead were measured in More than 180 samples of fresh raw buffalo's milk and house - made rural milk products including, Laban Rayeb, Cream, Samna, Kareish cheese and mish cheese. The spatial variability maps were generated using GIS.

2. Introduction

In recent years, risks of heavy metals that may pollute different foods have been receiving increased attention. Heavy metal contamination of milk is now considered to be a greater problem than that of pesticides **(FAO/WHO, 1997).**

Pollution of the environment with heavy metals such as lead and cadmium are world-wide problem. Lead alkyl as additives in petrol are combusted and emitted into the atmosphere and can be responsible for the high concentration of lead in some vegetation, roadside, soil, air, water and plants **(Burguera and Rondon, 1987).** Cadmium was presumed to be a possible source of environmental pollution through galvanized pipes and effluents from electroplating works and geological deposits **(Melgar, et al., 1997).**

Maximum limit admitted for Cadmium by Romanian regulation for milk and cheese is 0.05 ppm, the maximal limit for Lead in milk and cheese in Romania is 0.02 ppm **(Florea et al., 2006). (Codex Alimentarius Commission 2007)** established a limit for Pb in milk 0.02 ppm.

Since 1990s, GIS has been claimed as a magic tool in natural resource management "it is ultimate in GIS the perfect answer to each and every resource problem" **(Heit and Shortreid, 1991).** GIS is a powerful and sophisticated tool for displaying and analyzing spatial relationships between geographic phenomena in the form of vectors and images. With the advent of GIS, there are ample opportunities for a more explicitly reasoned land evaluation. Geographic data as spatial data that "result from observation and measurement of earth phenomena" is referenced to their locations on the earth's surface **(Tomlinson, 1987).** GIS is an information system including works and links together with the ability to perform numerous tasks utilizing both spatial and attribute data stored in it **(ESRI, 2001).** It has the ability to integrate variety of geographic technologies like Global Positioning System (GPS), and Remote Sensing (RS). The strength of GIS lies in its ability to integrate different types of data into a common spatial platform. This information should present both opportunities and constraints for the decision maker **(Ghafari *et al*., 2000).**

Data from different sectors can be integrated into a single analysis without the need for each sector duplicating data collection efforts. The powerful query, analysis and integration mechanism of GIS makes it an ideal scientific tool to analyze it for land use planning. Management of agricultural resources based on their potential and limitation is essential for development of land and other resources on sustainable basis. GIS technology is being increasingly employed by different users to create resource database and to arrive at appropriate solutions/strategies for sustainable development of agricultural resources **(Venkataratnam, 2002).** The building of a GIS is a chain of operations that leads from planning data observation and collection, to their storage and analysis, to the use of the derived information in some decision making process **(Chuong, 2007).**

From the above mentioned background the objectives of this paper have been formulated for assessment and mapping of some heavy metals contents in milk and rural dairy products in Sohag, Egypt using GIS techniques.

3. Materials

3.1. Study area:

Sohag area covers part of the Nile Valley, Egypt on the reach extending from the northern edge of Qena Governorate at latitude 26o 07′ N to the southern edge of

Assiut Governorate at latitude 26° 57′ N. It is bounded between longitudes 31° 20′ and 32° 14′ E (Fig. 1).

The study area belongs to the arid region of North Africa which is generally characterized by hot summer and mild winter with low rainfall. Air temperature ranges between 36.5°C (summer) and 15.5°C (winter), relative humidity ranges between 51% and 61% (winter), 33% and 41% (Spring), and 35% and 42% (Summer).
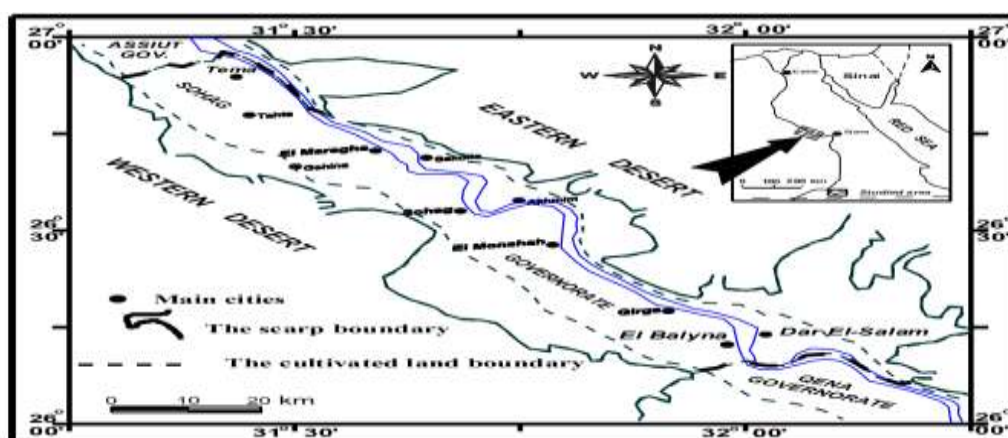

Fig. (1) Location map of the study area

3.2. Investigated samples

Raw buffalos milk and house - made rural milk products including, Laban Rayeb, Cream, Samna, Kareish cheese and Mish cheese (180 sample) were collected from 10 villages of Sohag Governorate. The villages are: Nza El-hesh, Enibes, Bnawett, Basona, Abar El-waqf, El-hwaweash, Arab El-sabha, Awlad Salem, El-mgabra and Mzata. All investigated raw milk Samples as well as the rural milk products were of buffalo's milk. The above samples were kept under cooling till the application for analysis to determine Cd and Pb contents.
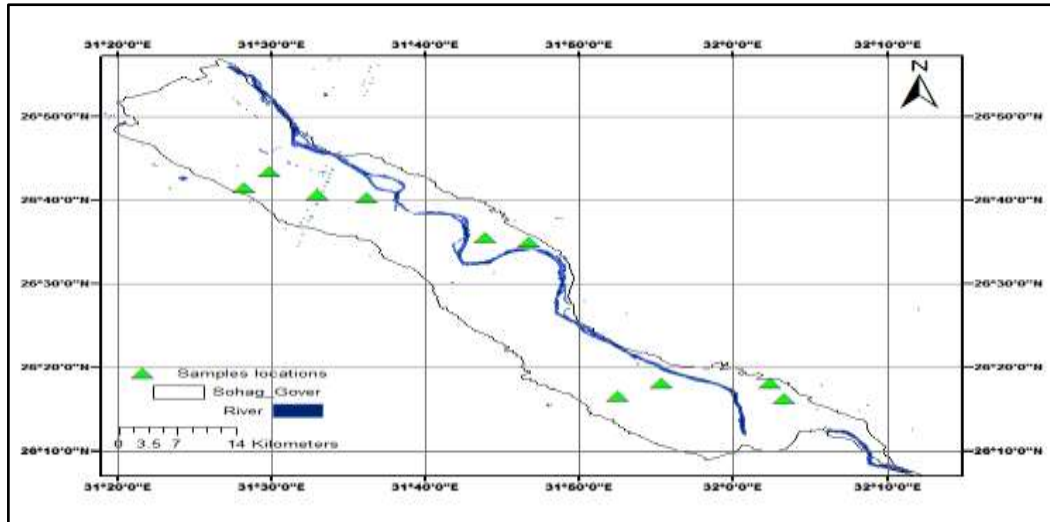
Fig. (2) Location map of the samples

4. Methodology:

4.1. Determination of Pb and Cd **elements**

The occurrence of Pb and Cd elements in samples had been estimated (ppm) according to the method of **(James 1995)**. The obtained ash was dissolved in 5 ml HCL (36.6%) and the volume was completed to 50.0 ml by distilled water. The dilutions were applied to the **ICAP6200 (ICP - OES)** device to estimate the levels of Cd and Pb in Central laboratory for Chemical Analysis, Faculty of Agriculture, Assiut University.

4.2. Generation of thematic maps

Inverse Distance Weighted (IDW) interpolation determines cell values using a linearly weighted combination of a set of sample points. The weight is a function of inverse distance. IDW lets the user control the significance of known points on the interpolated values, based on their distance from the output point. Thematic maps were generated for each of the parameters using IDW interpolation provided in Arc GIS 9.3 software developed by **ESRI (2011).**

5. Results and discussions:

5.1. Cadmium element (Cd) contents:

Results listed in Table (1) revealed that the mean value of Cd level in raw buffaloes milk was 0.023 ppm.

The obtained results were similar to those obtained by (**El-Gendy***et al***., 2007**) who found that the Cd levels in Assiut Governorate were 0.027 ppm at Arab El-Madabigh region and 0.020±0.013 ppm at Assiut University station, while it was lower than Cd values that obtained by (**Sharkawy and Hussein 2002**) 0.174 ppm**, (Amer, et al,; 2005**) 0.353 ppm and (**Enb et al., 2009**) 0.118 ppm.On the other hand data obtained by (**El-prince and Sharkawy 1999**) 0.019 ppm was lower than the present level.

The mean value of Cd levels in traditional cream samples was ranged from 0.015 ppm for samples of NzaElhesh village to 0.028 ppm for that of Mzata village, with an average of 0.020 ppm, which was lower than values obtained by (**Amer, et al; 2005**) who stated that the Cd contents in Cream was 0.088 ppm.

Generally, the variation of Cd levels in cream samples regarded to various investigated villages may be due to the environmental conditions related to each village.

Table (1): Cadmium concentrations of different raw milk and milk products collected from some villages of Sohag *

|	Cd ppm					
	Raw milk	**Laban Rayeb**	**Cream**	**Samna**	**kariesh cheese**	**Mish cheese**
NzaElhesh	0.036	0.02	0.015	0.018	0.047	0.072
Enibes	0.018	0.018	0.021	0.018	0.064	0.068
Bnawett	0.017	0.018	0.018	0.017	0.045	0.022
Basona	0.025	0.02	0.017	0.032	0.077	0.081
Abar El-waqf	0.019	0.017	0.022	0.018	0.069	0.044
El-hwaweash	0.017	0.024	0.021	0.019	0.020	0.018
Arab El-sabha	0.017	0.019	0.017	0.017	0.049	0.07
Awlad Salem	0.017	0.021	0.02	0.02	0.076	0.018
El-mgabra	0.025	0.02	0.024	0.027	0.046	0.07
Mzata	0.025	0.03	0.028	0.025	0.065	0.053
Average	0.022	0.021	0.020	0.021	0.056	0.051

* Values are average of three samples.

Data presents in Table (1) represents the mean value of Cd concentrations samples of Samna ranged from 0.017 ppm for Samples obtained from both of Bnawett and Arab el-sabha villages to 0.035 ppm for that from El-masead village

The average value of Cd contents of Kariesh cheese samples was 0.056ppm, which was was lower than that obtained by (**Mohran et al., 2010**) and (**Bakry, 2012**), while (**Abdou and Korashy, 2001**) had not detected Cd in Kariesh cheese collected randomly from different localities of Upper Egypt.

The determined values of Cd contents in Mish cheese samples obtained from various villages listed in Table (1). It was found that, Mish cheese samples collected from Basona village recorded the highest value with 0.081ppm, while the lowest one was found in samples of both El-hwaweash and Awlad Salem with 0.018 ppm. The various values of all samples gave 0.051 as a general average.

The obtained data can be represent in graphically form by using GIS (figures 3). At a first glance, there were recorded values above safe limits for Cd in karish and missh. Contrary to that, all recorded under safe limits for Cd in other products. Generally, the variation of Cd high levels in cream samples regarded to various investigated villages may be due to the environmental conditions related to each village.
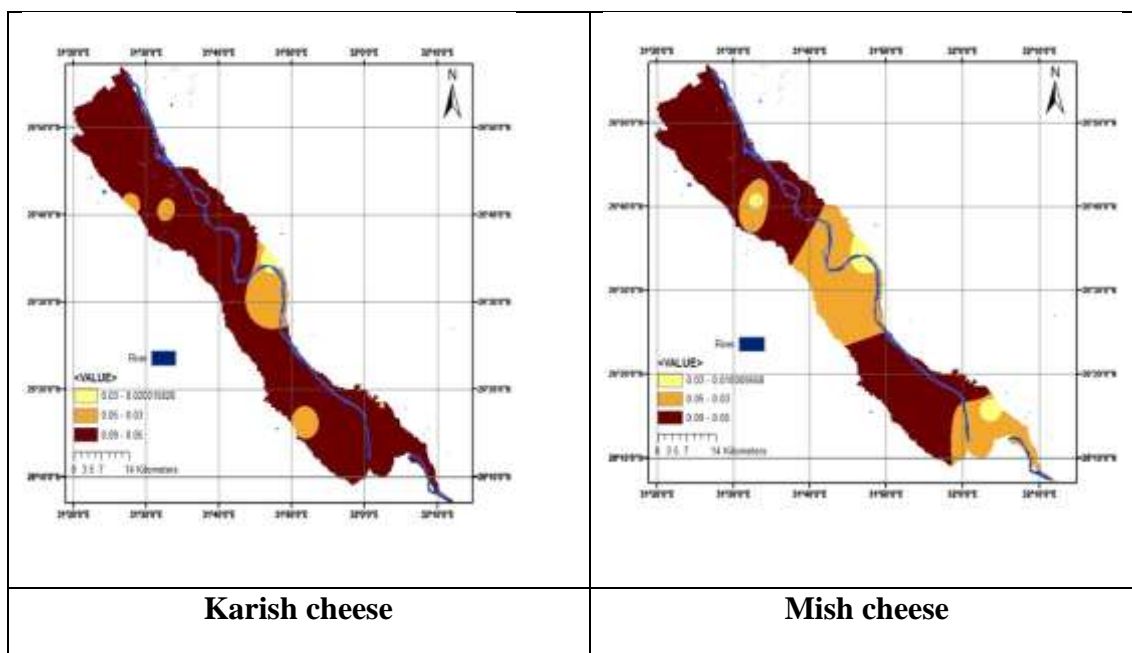
Raw milk	Cream
Samna	Rayib

| Karish cheese | Mish cheese |
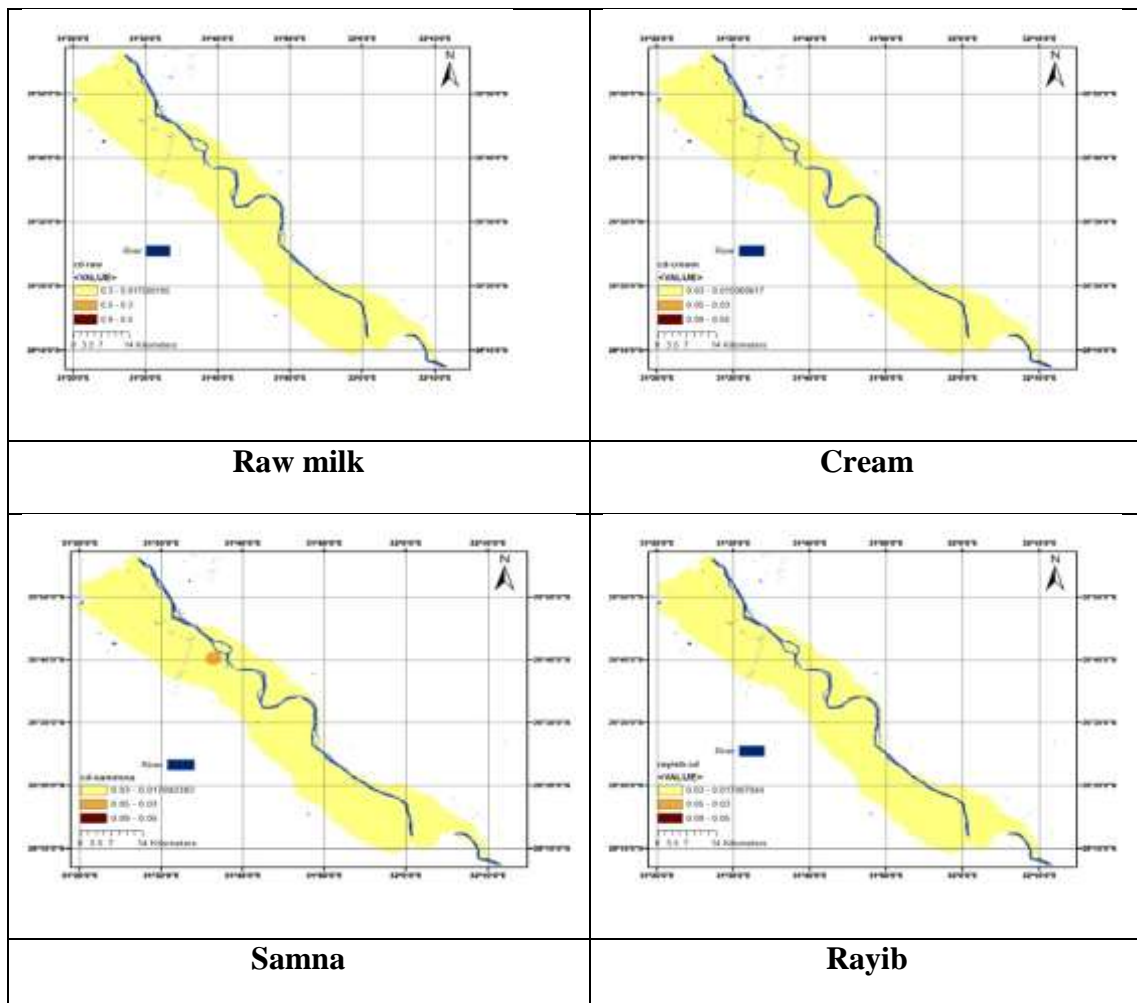
Fig. (3) Cd concentrations in the samples collected from the study area

The results highlight the most probable hot spots areas that increase the human health problems. Also, these areas could be distinctly targeted/prioritized on maps This type of regional scale (spatial) information is in fact highly desired by the decision makers for achieving sustained/increased the quality of these milk products.

2. Lead element (Pb) contents:

The lead concentrations of raw milk samples obtained from various villages related to Sohag Governorate are presented in Table (2). Both Arab El-sabha and El-mgabra villages showed the lowest values with 0.01 and 0.013 ppm respectively, while the highest one was given by raw milk samples of NzaElhesh village with 0.484 ppm. The obtained data of Pb concentration was nearly similar to those obtained by **(Enb,** *et al***., 2009)** 0.084 ppm, while it was higher than results reported by **(Sreedhar,** *et al***., 2009)** 0.015 ppm**.** On the other hand it was lower than those reported by **(El-Gendy, et al., 2007)** 0.156 to 0.264 ppm**.**

The mean value of lead contents in samples of Laban rayeb, lied between 0.015 and 0.205 ppm for samples obtained from Basona and NzaElhesh villages respectively, with an average of 0.070 ppm.

Table (2): Lead concentration of different raw milk and milk products collected from some villages of Sohag Governorate.*

	Pb ppm					
	Raw milk	Laban Rayeb	Cream	Samna	kariesh cheese	Mish cheese
NzaElhesh	0.484	0.205	0.099	0.123	1.206	4.965
Enibes	0.114	0.112	0.215	0.108	1.855	11.35
Bnawett	0.067	0.072	0.102	0.183	0.872	0.162
Basona	0.09	0.015	0.072	0.107	2.456	2.474
Abar El-waqf	0.055	0.042	0.171	0.093	2.103	1.337
El-hwaweash	0.031	0.105	0.023	0.103	0.159	0.097
Arab El-sabha	0.01	0.017	0.03	0.026	2.506	2.188
Awlad Salem	0.029	0.038	0.037	0.043	1.872	0.094
El-mgabra	0.013	0.048	0.04	0.029	1.988	2.678
Mzata	0.09	0.044	0.081	0.025	1.79	1.19
Average	0.098	0.070	0.087	0.084	1.681	2.654

* Values are average of three samples.

As indicated in Table (2), the mean values of Pb levels in traditional cream samples ranged from 0.023ppm for samples of El-hwaweash village to 0.215 ppm for that of Enibes village, with an average of 0.087 ppm, which was lower than values obtained by (**Amer, et al; 2005**) who stated that the Pb contents in Cream was 0.492 ppm.

Results listed in Table (2), it could be noticed that the mean value of lead concentrations of Samna was nearly similar to that of cream (0.084) ppm. The value obtained from samples of Bnawett village was the highest with 0.183 ppm, while the lowest concentration was given by sample belonged to Mzata village with 0.025 ppm

As shown in Table (2) the average of Pb contents in Kareish cheese samples was 1.681 ppm, which varied from 0.159 ppm that given by samples obtained from El-hwaweash village to 2.506 ppm for samples of Arab El-sabha village. It was observed that the values of sample from Awlad Salem and Enibes villages showed nearly the same levels of 1.872 and 1.855 ppm respectively. The present mean value of Pb content of Kareish cheese samples was higher than that obtained by (**Mohamed, 2008**) and (**Bakry, 2012**), while it was lower than that obtained by (**Mohran, et al., 2010**).

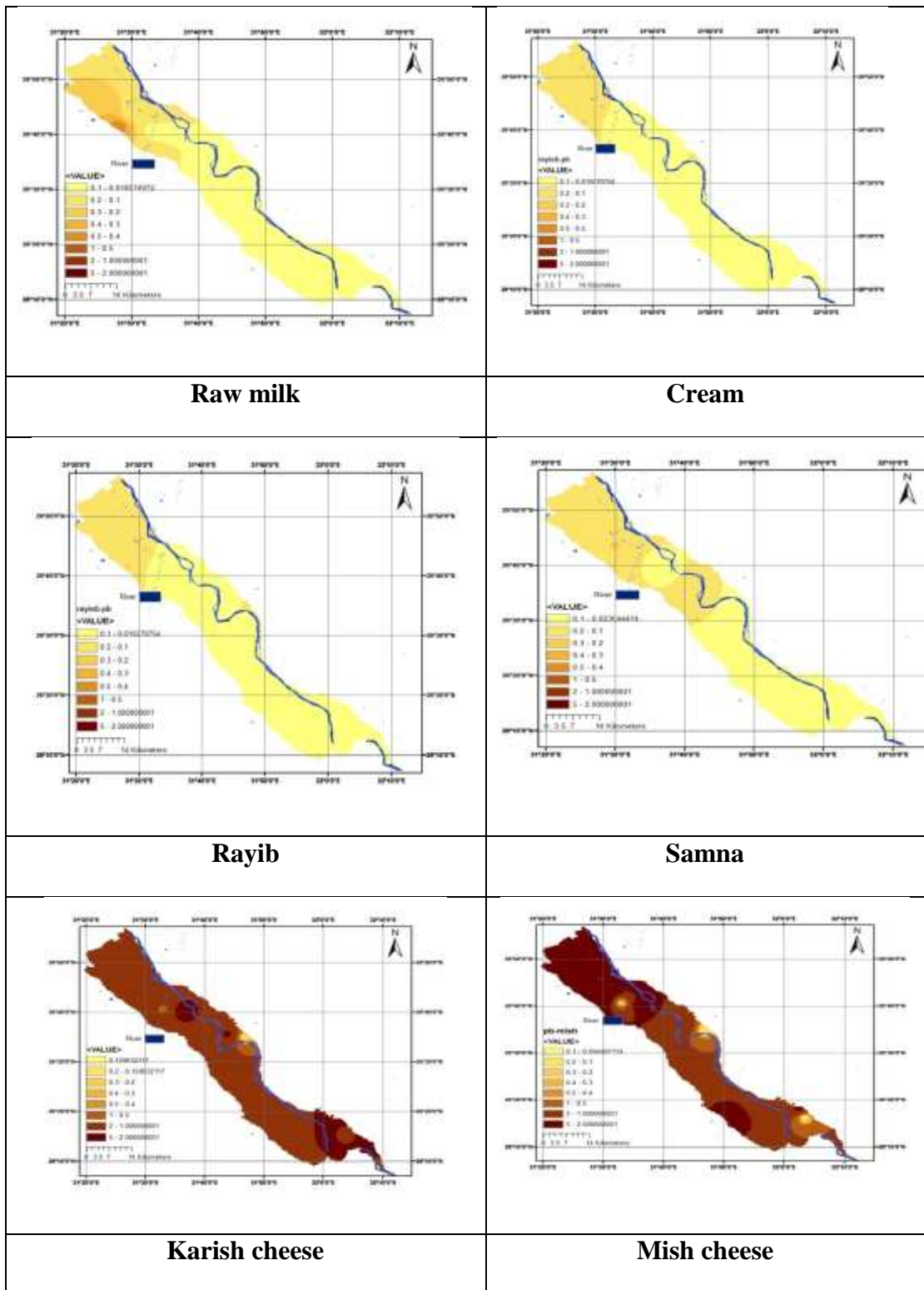|	
Raw milk	**Cream**
Rayib	**Samna**
Karish cheese	**Mish cheese**

Fig. (4) Pd concentrations in the samples collected from the study area

The Pb values in Mish cheese samples collected from different villages related to Sohag Governorates were listed in Table (2). It was found that, the average level of Pb contents was 2.654 ppm.

As mentioned in Cd results, Pd levels have the same trend in all examined samples. But, the increased levels of Pb in Karish and Mish were very high exceeded 20 times the safe limits in some places (figure 4).

6.Conclusion:

This is a pioneer study documented the some heavy metals load in the milk products in Sohag. The study revealed that levels of Cd and Pb in raw milk and its different products were above safe limits in both Mish cheese and Kariesh cheese. These findings have serious implication for public health. The results highlight the most probable hot spots areas that increase the human health problems. Also, these areas could be distinctly targeted/prioritized on maps This type of regional scale (spatial) information is in fact highly desired by the decision makers for achieving sustained/increased the quality of these milk products.

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نظم المعلومات الجغرافية في تقييم بعض المعادن الثقيلة في اللبن ومنتجات الألبان الريفية في محافظة سوهاج، مصر

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أجريت هذه الدراسة لتقييم ورسم خرائط لتركيزات بعض العناصر النادرة في اللبن الخام الجاموسي وبعض منتجات الألبان الريفية والتي تم جمعها من بعض القرى في محافظة سوهاج. والقرى التي تم تمثيلها هي نزة الهيش، وعنيبس، وبناويط، وباصونة، وأبار الوقف، والحواويش، وعرب الصبحة، وأولاد سالم، والمجابرة، ومزاتا، وقد تم قياس الكادميوم والرصاص في أكثر من ١٨٠ عينة من اللبن الجاموس الخام ومنتجات الألبان الريفية والتي تتضمن اللبن الرايب والقشدة والسمنة والجبنة القريش وجبن المش. وقد تم إنشاء خرائط لتقييم التركيزات المكانية باستخدام نظم المعلومات الجغرافية.